**Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
A99.4
F76
1953

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY

Reserve
BOOK NUMBER
880969

A99.4
F76
1953

3321

# TASK VII - TRENDS OF TIMBER GROWTH, TIMBER GROWTH OUTLOOK, REGIONAL GROWTH GOALS, AND NEEDED GROWING STOCK

TIMBER RESOURCE REVIEW

Revised April 24, 1953

Primary responsibility: Alaska Research Center, CAL, CS, LS, NE, NRM, PNW, RM, SE, SS and SW

LIBRARY
RECEIVED
MAR 29 1955
U. S. DEPT. OF AGRICULTURE

U. S. Department of Agriculture

Forest Service

Washington, D. C.

# TASK VII - TRENDS OF TIMBER GROWTH, TIMBER GROWTH OUTLOOK, REGIONAL GROWTH GOALS, AND NEEDED GROWING STOCK

Contents


| | | Page |
|---|---|---|
| A. | INTRODUCTION | 1 |
| | Relation to Reappraisal Project Calculations | 2 |
| B. | TRENDS OF TIMBER GROWTH SINCE 1945 | 2 |
| C. | TIMBER GROWTH AND GROWING STOCK OUTLOOK | 2 |
| D. | GROWTH GOALS | 4 |
| | Establishment of national growth goals for 2000 | 4 |
| | Estimation of the realizable growth capacity of each TRR region | 5 |
| | Allocation of long-range national growth goals to TRR regions | 5 |
| E. | NEEDED GROWING STOCK | 5 |
| F. | WORK SCHEDULE | 6 |
| G. | DATA FROM OTHER TASKS AND DATE NEEDED | 7 |
| H. | DEFINITIONS | 7 |
| I. | APPENDIX | 9 |
| | Tables 1 - 9 | 10-18 |
| | Sample calculations: projection of saw-timber growth and growing stock 1952-2000 | 19 |

# TASK VII - TRENDS OF TIMBER GROWTH, TIMBER GROWTH OUTLOOK, REGIONAL GROWTH GOALS, AND NEEDED GROWING STOCK

## A - INTRODUCTION

Concern about timber supplies is in the main over whether the forests will be able to satisfy future timber requirements. Is the trend of growth and growing stock in the right direction? Are the forestry programs we propose geared up to the needs of an expanding national economy? These are two important questions that should be answered in any analysis of the timber supply situation. The purpose of Task VII is to relate present timber stands, growth, and forestry trends to future wood requirements.

This analysis will involve four separate sets of calculations in both board feet and cubic feet showing softwoods and hardwoods separately: (1) analysis of trends of timber growth since 1945, (2) projection of trends of growth and growing stock to the year 2000, (3) establishment of timber growth goals for the year 2000 to meet probable timber product requirements with a margin for safety, and (4) estimation of the growing stocks needed to sustain the growth goals for 2000. The over-all purpose of these calculations is, first, to estimate where recent forestry trends might lead us under different assumptions of timber products output, and second, to compare these trends with reasonable growth and growing stock objectives, evaluating the results in terms of the adequacy of existing programs.

Stations and regional offices should work together in Task VII. However, the leadership and responsibility for submitting the required data for each TRR region will rest in the following stations:

| TRR Region | Assignment |
|---|---|
| New England | NE |
| Middle Atlantic | NE |
| South Atlantic | SE |
| Southeast | SS |
| West Gulf | SS |
| Central | CS |
| Lake | LS |
| Plains | RM |
| North Rocky Mt. | NRM |
| South Rocky Mt. | SW |
| California | CAL |
| Pacific Northwest | PNW |
| Coastal Alaska | Alaska Research Center |

Except for Section B, Trends of Timber Growth Since 1945, all of the computations should be by TRR regions. In each instance the experiment station with the leadership assignment should determine the computation method to be used. To the extent feasible, other stations and regional offices operating in the TRR region should be consulted as to methodology. They should also collaborate in supplying the data needed for the calculations.

(Over)

Section B, Trends of Timber Growth Since 1945, should be done by states, the responsibility for individual states being as in Task VI. Regional summaries should be made by the stations listed above.

Relation to Reappraisal Project Calculations. The first detailed analyses of this sort were made in connection with the Reappraisal Project of 1945. Pages 40-46 of Gaging the Timber Resources of the United States present the findings of these analyses. A detailed explanation of the reappraisal calculations was contained in the Report of the Committee on Allowable Cut, Required Growing Stock, and Growth Goals (July 15, 1948, RE-FOREST SURVEY-General). It should be studied to provide background as to methodology. The work sheets for this phase of the reappraisal project in each region likewise will be helpful.

Except as modified by changes in definitions of net growth, etc., the concepts of growth goals and needed growing stock are the same as in the reappraisal project. However, the projections of growth and growing stock contemplated for the TRR will differ from the reappraisal projections. In the reappraisal project an attempt was made to portray future courses of growth, growing stock, and cut which would lead to achievement of the growth goal in 75 years. In the TRR it is proposed to project growth and growing stock on the basis of recent forestry trends and three different assumptions as to rate of cutting, without regard to growth goals.

## B - TRENDS OF TIMBER GROWTH SINCE 1945

Past trends of timber growth have been obscured by lack of comparability of the various national estimates. The purpose of this analysis, therefore, is to adjust reappraisal project estimates of growth in 1945 to concepts and standards of the TRR (assignment, field).

Among the factors to take into consideration in adjusting reappraisal statistics are: change in definition of net growth and growing stock, changes in the commercial forest acreage, changes in utilization standards, inclusion of additional species, changes in techniques of growth calculation, improved estimates of timber volume. There are probably others. Estimates for 1945 for each state, adjusted to be comparable with TRR estimates, should be entered in Table 1 and summarized by regions. A statement should be submitted indicating how the adjustments were made.

## C - TIMBER GROWTH AND GROWING STOCK OUTLOOK

The purpose of these calculations is to determine whether recent trends in forestry are sufficient to build up future timber growth to the point where it will satisfy future timber requirements (assignment, field and Washington office).

Because timber is a long-term crop, it is necessary to project these calculations to at least the end of the century. Establishment of growth goals for any earlier period will not suffice because it will take 50 years or more for any program of forestry to be fully reflected in annual growth.

The projections of growth and growing stock will be made by regions for the period 1952-2000. To facilitate interpretations and comparisons, use the same periods in these projections as are used in the sample calculation in the appendix of the plan.

Projection 1 (Table 2). Project growth and growing stock in cubic feet and board feet to the year 2000 under the following assumptions:

1. The timber products output of each region will continue the trend indicated by industrial and economic developments of recent years. In other words, the projected output in each region should represent the best informed opinion as to a likely course of development under the general economic assumptions of Task IV, taking into account recent industrial expansions, access road situation, competition for wood, timber supply, economic limitations, andother such factors.

2. Forestry in the United States will continue to progress at a rate which appears likely from recent trends. Such factors as probable improvements in protection, management, and possible extent of future planting should all be taken into account from the standpoint of their effect on growth.

Projection 2 (Table 3). Project growth and growing stock in cubic feet and board feet to the year 2000 under the following assumptions:

1. The average annual timber products output in the United States as a whole will remain at the 1952 level until 2000.

2. The annual timber products output between now and 2000 will be allocated to the TRR regions on the basis of the outlook and limitations of each region as indicated in projection 1. (The allocation will be done by the Washington office.)

3. Forestry in the United States will continue to progress at a rate which appears likely from recent trends. (Same as projection 1.)

Projection 3 (Table 4). Project growth and growing stock in cubic feet and board feet to the year 2000 under the following assumptions:

1. The annual timber products output in the United States as a whole will climb steadily until 1975 to the level of requirements for that period, and then progress steadily to the level of requirements in the year 2000.

2. The annual timber products output between now and 2000 will be allocated to the TRR regions on the basis of the outlook and limitations of each region as indicated in projection 1. (The allocation will be done by the Washington office.)

3. Forestry in the United States will continue to progress at a rate which appears likely from recent trends. (Same as projection 1.)

The quantitative changes which will take place in the growing stock and growth in these projections will be the composite result of the trends in growth, mortality, and cutting. These trends of course will be affected by forestry programs and changes in utilization practices as well as by the volume of cut. It is important, therefore, in projecting the growth and growing stock to relate the trends of growth and cut to trends in planting, protection, forest area, utilization, and management. The calculations should clearly show how much each separable factor individually affects growth, timber cut, and growing stock, and should of course be as realistic and complete as possible, giving consideration to all factors--negative as well as positive--influencing growth, timber cut, and growing stock. The degree to which it will be possible to correlate rates of change with programs and practices will decrease as the projections reach farther into the future. A sample calculation is attached suggesting a procedure for taking such factors into account. It is intended as a suggestion only, along with the Report of the Committee on Allowable Cut, Required Growing Stock, and Growth Goals. Each station with leadership responsibility should devise a system of calculations applicable to conditions in its region and the types of data available.

Sample calculations indicating the procedures proposed under the assumptions of projection 1 should be submitted to the Washington office by December 1, 1953, for review prior to East and West conferences on this task (section F).

The assumptions with regard to cutting rates require projection 1 to be made first. After review of the regional data for projection 1, the Washington office will divide the assumed national trends of timber products output in projections 2 and 3 between the regions for calculation of the growth and growing stock outlook under these assumptions.

A short statement should be prepared in the field for each TRR region appraising each of the principal factors which will influence the trend of growth, and growing stock: for example, stepped-up planting in the South and its effect on in-growth; rate of timber access road development in the West and resultant effects.

## D - GROWTH GOALS

The purpose of these calculations is to estimate what annual timber growth in the United States and in each TRR region should be in the year 2000 to assure adequate supplies of timber to meet timber product requirements at that time.

(a) Establishment of national growth goals for 2000. (Assignment, Washington office.) The growth goals will consist of two parts: (1) timber product requirements of the United States in 2000 converted to timber cut (determined in Task IV), (2) a margin for safety. Specifically, the margin will allow for: catastrophic losses, new forms of wood use, growth which cannot be utilized for some reason or another, exports, and stockpiling on the stump for times of national emergency. The data will be entered in Table 5. There is no mathematical basis for determining what the margin should be. The aim will be to set a margin which will take all factors into account in a realistic manner, so as to establish

a goal that will adequately reflect national responsibilities for security, better living, and world leadership.

(b) Estimation of the realizable growth capacity of each TRR region. (Assignment, field.) The purpose of these estimates is to take a fresh look at the capacity of the regions to produce wood in 2000. Estimates should be on a net growth basis. The estimates of growth capacity should not be influenced by regional growth goals set up in the 1945 Reappraisal. Neither should we attempt to determine the full biological growth potential without regard for economic limitations. The objective is to obtain for each region a realistic estimate of a growth potential which it would be practical to attain in 2000 if all landowners applied the intensity of forestry justified under the price relations and high-level national economy assumed in making the requirements estimates of Task IV. These estimates of realizable growth capacity should be entered in Table 6.

In estimating growth capacity account should be taken of improvements in utilization practices which appear feasible under the assumed conditions. Likewise, allowance should be made for changes in forest area and for advances in forestry which it seems practical to aim for, i.e., improved protection, increased planting, better cutting, etc. Such allowance may well go beyond that indicated by present trends in Section C, Timber Growth and Growing Stock Outlook.

Indicate in a brief narrative statement whether consideration of watershed, wildlife, and recreation management on commercial forest land would lead to setting the realizable growth capacity higher or lower than is the case with only timber production factors taken into account, and state how much the difference would be.

(c) Allocation of long-range national growth goals to TRR regions. (Assignment, Washington office and field.) The cubic-foot and board-foot growth goals for the year 2000 will be subdivided into regional goals on the basis of the realizable growth capacities determined in (b) above with such adjustments as appear necessary after consideration of factors related to regional balances of supply and demand such as: species and quality of timber grown in each region, prospective differences in timber production costs and intensity of forestry between regions, position of regions with respect to centers of consumption, relation of timber growing to watershed protection, recreational needs, and other aspects of regional economic development. The goals will be entered in Table 7. The allocation will be done by the Washington office and submitted to the regions and stations for review, prior to final allocation by the Washington office.

## E - NEEDED GROWING STOCK

The purpose of these calculations is to determine for each TRR region the timber stand needed to sustain net growth at the level set by the long-range growth goal as finally allocated (Table 7). The data should be entered in Table 8 (assignment, field).

The most important factor in the above estimates is the assumed relationship between growth and growing stock. The ratios used should depend on (1) the growth rates of the species involved, (2) reduction of mortality from fire, insects, and disease to a practical minimum (mortality reduction objective), (3) rotations long enough to provide timber of desirable quality and of a size to assure an output of saw-timber products commensurate with requirements estimates, and (4) yield taken from thinnings under an intensity of management no more than necessary to achieve the growth goals by the year 2000. This would probably be intermediate between that now in practice and what would be needed to achieve "realizable growth capacity."

Mortality reduction objectives, expressed as mortality rates, will have been determined in Task IX. These rates will be used in estimating assumed future levels of mortality in board feet and cubic feet which should be entered in Table 9.

## F - WORK SCHEDULES

This task depends upon several others for basic data and cannot, therefore, be started before the fall of 1953. The field phases of the study are scheduled for completion by September 1, 1954. To assure adequate attention, each station and region should assign responsibility for the task and for having the data submitted according to the following schedule:

| | |
|---|---|
| 1953--December 1. | Field submit to Washington office sample calculation for Section C, Timber Growth and Growing Stock Outlook. |
| 1954--January. | Eastern and western meetings of project leaders to discuss procedures and consider possibility of coordinated approach. |

### Past Trends

| | |
|---|---|
| 1954--March 1. | Field submit to W.O. estimates of 1945 growth converted to TRR standards. |

### Growth Goals

| | |
|---|---|
| 1954--April 1. | Field submit to W.O. estimates of realizable growth capacity. |
| 1954--April 1. | Washington office completes calculation of national growth goals. |
| 1954--May 1. | Washington office submits to field preliminary allocation of growth goals for review. |
| 1954--May 15. | Field submits to W.O. comments on allocations. |
| 1954--June 1. | Washington office submits to field final allocation of growth goals. |

Needed Growing Stock

| | |
|---|---|
| 1954--July 1. | Field submits to Washington office estimates of needed growing stock. |

Growth Outlook

| | |
|---|---|
| 1954--June 1. | Field submits to Washington office growth and growing stock projection 1. |
| 1954--July 1. | Allocation by Washington office to field of assumed trends of cut for projections 2 and 3. |
| 1954--September 1. | Field submits to Washington office growth and growing stock projections 2 and 3. |
| 1954--December 1. | Final report Task VII completed by Washington office. |

G - DATA FROM OTHER TASKS AND DATE NEEDED

Task IV. Timber products requirements 1975 and 2000 expressed as timber cut (February 1, 1954).

Task V. Timber cut data for 1952 in Tables 2 and 3. (February 1, 1954)

Task VI. Timber volume, net growth, and mortality for 1952 in Tables 2 and 3 (April 1, 1954).

Task IX. (a) Estimates of objectives for ultimate mortality rates to be used in connection with the establishment of national and regional growing stock objectives. (b) Mortality rates in 1952 and estimated rates in 1965, 1975, 1985, and 2000 if present trends continue (May 1, 1954).

Task X. (Table 4) Probable trend of planting by regions between now and the year 1984 (February 1, 1954).

H - DEFINITIONS

Realizable Growth Capacity.* The annual net growth which it would be practical to attain in 2000 if all landowners applied the intensity of forestry justified under the price relations and high-level economy assumed in making the requirements estimates of Task IV.

National Growth Goal.* The annual net growth required to meet future wood requirements plus a margin for export, catastrophic losses, national emergencies, new forms of wood use, and other factors.

Regional Growth Goal.* The individual TRR region's share of the national growth goal based on growth capacity of the region, prospective differences in intensity of forestry between regions, position of regions with respect to centers of consumption, relation of timber growing to watershed protection, recreation needs, and other aspects of regional economic development.

Growing Stock. Net volume of live saw-timber trees and live pole-timber trees, from stump to a minimum 4.0-inch top (of central stem) inside bark.

Required Growing Stock.* The volume of timber stand required for the rotations decided upon to sustain net growth at the level of the national or regional growth goals, with the level of protection and management assumed when the goals are achieved. Total volume in cubic feet. Sawlog portion of saw-timber trees in board feet.

Sawlog Portion of Saw-timber Trees. The portion of saw-timber trees between the stump and merchantable top.

Annual Mortality. The volume removed from the live saw-timber or growing stock during a specified year through death from natural causes exclusive of catastrophic losses.

Net Annual Growth. The change during a specified year of net board-foot volume of live saw-timber or net cubic-foot volume of growing stock on commercial forest land resulting from natural causes exclusive of catastrophic losses.

Margin.* The margin in the national growth goals above anticipated timber requirement to allow for unusual and unexpected losses, new uses, unutilized growth, exports, and stock piling on the stump for times of national emergency.

---

* These are additional definitions not contained in the Forest Survey manual.

# I - APPENDIX

Hardwoods and softwoods need not be separated in the regions west of the Plains region.

TRR Region _____

Task VII. Table 1. - Adjusted Net Growth, 1945

| State 1/ | Annual growth of all growing stock | | | Saw-timber growth | | |
|---|---|---|---|---|---|---|
| | Total | Softwood | Hardwood | Total | Softwood | Hardwood |
| | (Million cubic feet) | | | (Million board feet) | | |
| | | | | | | |
| Total | | | | | | |

1/ Enter State or part thereof within the TRR Region.

TRR Region _____

Task VII. Table 2. - Projection 1. Timber volume and net growth 1952-2000 with regional timber products output progressing as indicated by recent trends

| Year | Timber volume | | | Timber cut | | | Mortality | | | Net growth | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total |
| | Total Growing Stock--million cubic feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |
| | Saw-timber--million board feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |

* 1952 data from Tasks V and VI.

TRR Region _____

Task VII. Table 3. - Projection 2. Timber volume and net growth 1952-2000 with national timber product output remaining at 1952 level

| Year | Timber volume | | | Timber cut 1/ | | | Mortality | | | Net growth | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total |
| | Total Growing Stock--million cubic feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |
| | Saw-timber--million board feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |

* 1952 data from Tasks V and VI.

1/ To be allocated by Washington office.

TRR Region _____

Task VII, Table 4. - Projection 3. Timber volume and net growth 1952-2000 with national timber product output advancing to meet estimated requirements.

| Year | Timber volume | | | Timber cut 1/ | | | Mortality | | | Net growth | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total | Hard-woods | Soft-woods | Total |
| | Total Growing Stock--million cubic feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |
| | Saw-timber--million board feet | | | | | | | | | | | |
| 1952* | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | |
| 1975 | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | |
| 2000 | | | | | | | | | | | | |

* 1952 data from Tasks V and VI.

1/ To be allocated by Washington office.

Task VII. Table 5. - National Growth Goal, 2000

| | Growth needed to meet timber product requirement** | Margin | Total |
|---|---|---|---|
| Growth goal for total growing stock | | | |
| Softwood (million cu. ft.) | | | |
| Hardwood (million cu. ft.) | | | |
| Total | | | |
| Growth goal for saw-timber | | | |
| Softwood (million bd. ft.) | | | |
| Hardwood (million bd. ft.) | | | |
| Total | | | |
| Softwood (million cu. ft.)* | | | |
| Hardwood (million cu. ft.)* | | | |
| Total | | | |

* Sawlog portion only.
** From Task IV.

TRR Region _____

Task VII. Table 6. - Realizable Growth Capacity in the Year 2000

| | Realizable Growth Capacity for Total Growing Stock | Realizable Growth Capacity for Saw-timber | |
|---|---|---|---|
| | Million cu. ft. | Million bd. ft. | Million cu. ft.* |
| Softwood | | | |
| Hardwood | | | |
| Total | | | |

* Sawlog portion only.

Task VII. Table 7. Regional Growth Goals, 2000

| Region | Growth goal for total growing stock | | | Growth goals for saw-timber | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Softwood | Hardwood | Total | Soft-wood | Hard-wood | Total | Soft-wood | Hard-wood | Total |
| | MM cu. ft. | | | MM bd. ft. | | | MM cu. ft. * | | |
| New England | | | | | | | | | |
| Middle Atlantic | | | | | | | | | |
| Lake | | | | | | | | | |
| Central | | | | | | | | | |
| Plains | | | | | | | | | |
| NORTH | | | | | | | | | |
| South Atlantic | | | | | | | | | |
| Southeast | | | | | | | | | |
| West Gulf | | | | | | | | | |
| SOUTH | | | | | | | | | |
| Pacific Northwest | | | | | | | | | |
| Douglas-fir subregion | | | | | | | | | |
| Pine subregion | | | | | | | | | |
| Total | | | | | | | | | |
| California | | | | | | | | | |
| North Rocky Mountain | | | | | | | | | |
| South Rocky Mountain | | | | | | | | | |
| WEST | | | | | | | | | |
| Alaska (Coastal) | | | | | | | | | |
| UNITED STATES | | | | | | | | | |

* Sawlog portion only.

TRR Region _____

Task VII. Table 8. - Needed Growing Stock, 2000

| | Needed Growing Stock |
|---|---|
| Total growing stock | |
| Softwood (million cu.ft.) | |
| Hardwood (million cu.ft.) | |
| Total (million cu.ft.) | |
| Saw-timber | |
| Softwood (million bd.ft.) | |
| Hardwood (million bd.ft.) | |
| Total (million bd.ft.) | |

TRR Region _____

Task VII. Table 9. - Mortality Reduction Objectives, 2000

| | Mortality |
|---|---|
| Total growing stock | |
| Softwood (million cu.ft.) | |
| Hardwood (million cu.ft.) | |
| Total (million cu.ft.) | |
| Saw-timber | |
| Softwood (million bd.ft.) | |
| Hardwood (million bd.ft.) | |
| Total (million bd.ft.) | |

## Sample Calculations: Projection of saw-timber growth and growing stock, 1952-2000

The following calculations, based on hypothetical data, are attached to indicate one method for projecting growth and growing stock under assumed trends of timber cut. Whether this method or some other is chosen for your region should depend on the character and condition of its forests, the approach to forest management most commonly used in the region, and the kind of data available. In any event, the calculations should take account of the trends of the major factors relating to future growing stock changes, but should avoid going into more detail than can be realistically supported.

A. Inventory 1952

| | |
|---|---|
| Commercial forest area | 50,000,000 acres |
| Saw-timber volume | 75,000 million board feet |

B. Mortality trends

The present rate of saw-timber mortality (obtained from Task VI) is 0.63 percent annually. It is divided by causes as follows:

| | | |
|---|---|---|
| Fire | 0.32 | percent |
| Insects | 0.14 | " |
| Diseases | 0.10 | " |
| Other | 0.07 | " |
| | 0.63 | " |

Task IX calculations indicate that mortality rates are likely to decline if present protection trends continue. Following are the trends foreseen. (The detailed analysis of mortality rate trends would actually be done in connection with Task IX.)

(1) Fire. One-fourth of the forest area is not under organized fire protection. Fifty percent of the fire losses occur on this area. Present trends indicate that by 1965 the entire forest area will be under organized protection, and losses on the presently unprotected area will drop to the current level of loss on the area now protected. Between 1965 and 1975, losses on the presently unprotected area will drop 10 percent and between 1975 and 2000, another 10 percent.

Between 1952 and 1975, losses on the area now protected should decline 10 percent and between 1975 and 2000, another 10 percent.

Present mortality estimates and future mortality assumptions are presented in the following table:

| Year | Fire mortality -- percent | | |
|---|---|---|---|
| | 25 percent now unprotected | 75 percent now protected | Total |
| 1952 | 0.64 | 0.21 | 0.32 |
| 1965 | 0.21 | 0.20 | 0.20 |
| 1975 | 0.19 | 0.19 | 0.19 |
| 1985 | 0.18 | 0.18 | 0.18 |
| 2000 | 0.17 | 0.17 | 0.17 |

(2) Insects. Bark beetles account for 60 percent of the insect loss. The trend toward younger age classes and more intensified protection should reduce these bark beetle losses to 25 percent of the present level by 1975, at which point the mortality probably will stabilize. Other insect losses may be considered normal and probably will not be reduced.

| Year | Insect mortality -- percent | | |
|---|---|---|---|
| | Bark beetles | Other insects | Total |
| 1952 | 0.08 | 0.06 | 0.14 |
| 1965 | 0.05 | 0.06 | 0.11 |
| 1975 | 0.02 | 0.06 | 0.08 |
| 1985 | 0.02 | 0.06 | 0.08 |
| 2000 | 0.02 | 0.06 | 0.08 |

(3) Disease. Present efforts to control "X" disease are not proving successful. A 50 percent increase in disease mortality therefore appears probable by 1975. It is assumed that by that time control efforts will become effective, with the result that disease mortality will drop off to the present level by 2000.

| Disease mortality | |
|---|---|
| 1952 | 0.10 percent |
| 1965 | 0.13 " |
| 1975 | 0.15 " |
| 1985 | 0.13 " |
| 2000 | 0.10 " |

(4) Other losses. No change from present rate of .07 is foreseen.

(5) Summary of mortality loss rates from all causes:

| Period | First year of period (percent) | Average for period (percent) |
|---|---|---|
| 1952-1964 | 0.63 | 0.57 |
| 1965-1974 | 0.51 | 0.50 |
| 1975-1984 | 0.49 | 0.47 |
| 1985-1999 | 0.46 | 0.44 |
| 2000+ | 0.42 | - |

C. Ingrowth

The present ingrowth of pole trees into saw-timber size averages 49 board feet per acre per year. Present indications are that the annual ingrowth will more than double during the next half century due to better protection, better management of many larger holdings, and accelerated planting. Some of these improvements will be offset by the present tendency to obtain a greater proportion of the timber production from under-sawlog-size trees. This factor, however, appears overshadowed by the others.

These changes will be discussed under four headings: (1) number of young trees in various size classes, (2) pattern of cut of pole timber, (3) planting

of deforested and nonforest area, (4) natural restocking of deforested and nonforest area.

(1) Number of young trees in various size classes. Both improved fire protection and improvement in cutting practices have served to increase the stocking of young trees in recent years. These improvements will tend to increase saw-timber ingrowth for about 30 years. After about 30 years the ingrowth will probably stabilize at this level for several decades. Following is an estimate of the increase in ingrowth per acre per year on presently stocked areas as indicated by present stand data and trends, before allowance for changes in the cut of pole timber.

| Period | Increase in ingrowth over 1952 | |
|---|---|---|
| | First year of period | Average for period |
| | Bd. ft. per acre per year | |
| 1952-1964 | 0 | 5 |
| 1965-1974 | 10 | 20 |
| 1975-1984 | 30 | 40 |
| 1985-1999 | 50 | 50 |
| 2000 | 50 | - |

(2) Pattern of cut of pole timber. Pulp mill expansion in this region in the past two decades has adversely affected the ingrowth because of the heavy cut of pole-size trees.

The increasing demand for pulpwood will throw a heavier load on the small timber for a number of years. Some of the pole-timber cut will come from trees which otherwise would die before reaching saw-timber size, but the net effect is to reduce future saw-timber ingrowth. The following table shows how the cut of pole timber might increase if present trends continue. It also shows the impact of this trend on ingrowth into saw-timber size.

| Period | Cut of pole timber first year of period | Decrease of saw-timber ingrowth per acre from 1952 due to this factor * | |
|---|---|---|---|
| | | First year | Average |
| | Cords | Board feet | |
| 1952-1964 | 1,200,000 | - | 2 |
| 1965-1974 | 2,400,000 | 6 | 8 |
| 1975-1984 | 3,000,000 | 9 | 9 |
| 1985-1999 | 3,000,000 | 9 | 9 |
| 2000 | 3,000,000 | 9 | - |

* Assuming 20 percent will come from trees which will die before reaching saw-timber size. (300 board feet per cord.)

(3) Planting. Except as it was interrupted by the war, planting in this region has steadily increased since 1930. Increased use of mechanical planting equipment has given this trend new impetus, and it appears there will be

substantial further expansion. Approximately 100,000 acres were planted in 1952. We have assumed that the annual plantings will increase to 200,000 acres in 1975, at which point they will stabilize. Each planting will have its effect on saw-timber ingrowth 30 to 40 years after planting. We have assumed an ingrowth of 5,000 board feet per acre planted at 35 years.

| Period of planting | Acres planted annually | Period when ingrowth would be effective | Ingrowth per year per acre of commercial forest in region (1952) (bd. ft.) |
|---|---|---|---|
| - | - | 1952-1964 | - |
| 1930-1939 | 52,700 | 1965-1974 | 5 |
| 1940-1949 | 26,100 | 1975-1984 | 3 |
| 1950-1964 | 130,000 | 1985-1999 | 13 |
| 1965 | 160,000 | 2000 | 16 |

(4) Natural restocking. There are approximately 900,000 acres of deforested land which will probably restock naturally between now and 1965. Another 450,000 acres of abandoned farm land are expected to restock naturally in the same period. However, this increase in forest area will be partially offset by the expected removal of 150,000 acres from the forest category by clearing for farms, new highways, power rights-of-way, reservoirs, etc. This removal will reduce the acreage contributing to ingrowth in the future. Thus the net effect of these changes will be to add the ingrowth of 1,200,000 acres in the period 1985-1999. Assuming 3,000 board feet per acre ingrowth on the 1,200,000 acres, the increase in ingrowth related to the present commercial forest acreage would be:

$$\frac{1{,}200{,}000 \text{ acres} \times 3{,}000 \text{ bd. ft.}}{50{,}000{,}000 \text{ acres} \times 15 \text{ years}} = 5 \text{ bd. ft.}$$

(5) Summary. Trend of saw-timber ingrowth, board feet per acre per year.

| Factor | Period 1952-1964 | 1965-1974 | 1975-1984 | 1985-1999 | 2000 |
|---|---|---|---|---|---|
| Present rate | 49 | 49 | 49 | 49 | 49 |
| Increased stocking | 5 | 20 | 40 | 50 | 50 |
| Increase in pole-timber drain | -2 | -8 | -9 | -9 | -9 |
| Planting | - | 5 | 3 | 13 | 16 |
| Natural restocking | - | - | - | 5 | - |
| Average for period --total | 52 | 66 | 83 | 108 | 106 |
| First year of period | 49 | 58 | 73 | 108 | 106 |

D. Gross growth on saw-timber

The present gross growth rate on the saw-timber portion of the growing stock is 3.4 percent. It is a rather rapid rate induced by a general deficiency of stocking. For that reason improvements in management are going to have a smaller effect upon growth rate than upon timber quality. Continuation of present trends appears to indicate a 20 percent increase in growth percent by 1975, a rate which will then be maintained to the end of the century.

| Period | Estimated growth percent on saw-timber | |
|---|---|---|
| | First year | Average |
| 1952-1964 | 3.4 | 3.5 |
| 1965-1974 | 3.7 | 3.9 |
| 1975-1984 | 4.0 | 4.1 |
| 1985-1999 | 4.1 | 4.1 |
| 2000 | 4.1 | 4.1 |

E. Trend of saw-timber cut

The saw-timber cut allocated to this region under the assumptions of projection 2 is shown in the following table:

| Period | Annual saw-timber cut | |
|---|---|---|
| | As allocated | Adjusted |
| | Million board feet | |
| 1952-1964 | 6,100 | 5,700 |
| 1965-1974 | 6,000 | 5,200 |
| 1975-1984 | 5,900 | 5,100 |
| 1985-1999 | 6,000 | 5,200 |
| 2000+ | 6,000 | 5,200 |

The adjustments shown in the last column of this table are explained below.

Recent trends of improved utilization indicate that more cull and dead material will be used than in the past. This will reduce the impact of future commodity production on growing stock. We have assumed a reduction of 100 million board feet per year for the period 1952-1964 and 200 million board feet per year thereafter.

The timber industries are finding it necessary to obtain a larger part of their wood requirements from pole timber. Indications are that the dependence upon small trees will increase during the next half century. It is estimated that 5 percent of the allocated saw-timber cut will actually be taken from pole-timber material during the period 1952-1964, and 10 percent thereafter.

F. Projection of growing stock and annual growth

(1) Growing stock projection.

| Period | Growing stock beginning of period, MM bd. ft. | Mortality, percent (from p. 25) | Average annual growth: Per acre, bd. ft. (from p. 28) | Average annual growth: Total, MM bd. ft. | Average gross growth on saw-timber, percent (from p. 29) | Average annual cut, MM bd. ft. (from p. 29) |
|---|---|---|---|---|---|---|
| 1952-1964 | 75,000* | 0.57 | 52 | 2,600 | 3.5 | 5,700 |
| 1965-1974 | 59,221 | 0.50 | 66 | 3,300 | 3.9 | 5,200 |
| 1975-1984 | 59,233 | 0.47 | 83 | 4,150 | 4.1 | 5,100 |
| 1985-1999 | 72,036 | 0.44 | 108 | 5,400 | 4.1 | 5,200 |
| 2000 | 125,289 | 0.42 | 106 | 5,300 | 4.1 | 5,200 |

* From Task VI.

Formula used in projecting growing stock in the table above:

$$A = \left[\left(GS - \frac{1}{2}C - M\right).0s + I - (C + M)\right] \frac{(1.0x^n - 1)}{.0x}$$

A = addition to growing stock during the period

GS = growing stock at the beginning of the first year of the period

C = annual timber cut

M = volume at beginning of period times average mortality rate for period

s = average gross growth percent for the period not including ingrowth

I = annual ingrowth (average for the period)

n = length of period

x = s - mortality percent

<u>Example:</u> Calculation of growing stock in 1965 (col. 2)

$$\left[(75{,}000 - 2{,}850 - 428).035 + 2{,}600 - (5{,}700 + 428)\right] \frac{.450}{.029} + 75{,}000 = 59{,}221$$

when growing stock 1952 = 75,000

$\frac{1}{2}C$ = 2,850

M = 428

.0s = .035

I = 2,600

C = 5,700

.0x = .029

$1.029^{13} - 1$ = .450

(2) Growth projection.

| Year | Growing stock MM bd. ft. | Mortality percent | Ingrowth: Per acre bd. ft. | Ingrowth: Total MM bd. ft. | Gross growth on saw-timber, percent | Annual cut MM bd. ft. | Annual net growth MM bd. ft. |
|---|---|---|---|---|---|---|---|
| 1952 | | | | | | | 5,100* |
| 1965 | 59,221 | 0.51 | 58 | 2,900 | 3.7 | 5,200 | 4,700 |
| 1975 | 59,233 | 0.49 | 73 | 3,650 | 4.0 | 5,100 | 5,600 |
| 1985 | 72,036 | 0.46 | 108 | 5,400 | 4.1 | 5,200 | 7,900 |
| 2000 | 125,289 | 0.42 | 106 | 5,300 | 4.1 | 5,200 | 9,800 |

* From Task VI.

Formula used in projecting growth in the table above:

$$NG = (GS - \tfrac{1}{2}C - M).0s + I - M$$

NG = net growth
GS = growing stock
M = volume at beginning of year times mortality rate for first year of period
s = growth percent for first year of period not including ingrowth
I = annual ingrowth (first year of period)
C = annual timber cut

Example: Calculation of net growth in 1965

$$(59,221 - 2,600 - 302).037 + 2,900 - 302 = 4,682$$

GS = 59,221
M = 302
$\frac{1}{2}C$ = 2,600
.0s = .037
I = 2,900

Note that the mortality rate, growth rate, and ingrowth in this calculation are for specific years whereas the rates of the preceding calculation are for periods.